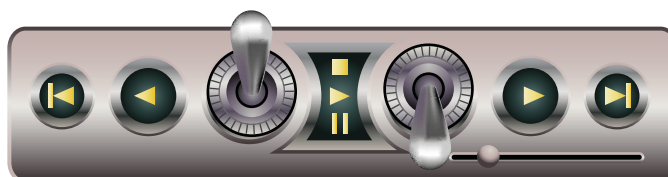


Flight Surgeon Refresher Course

Section 4: Aviation Safety

Accident Investigation
(FSRC404)



ACCIDENT INVESTIGATION

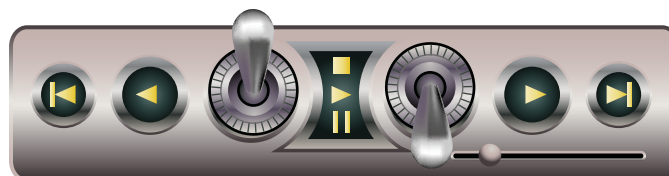
Introduction

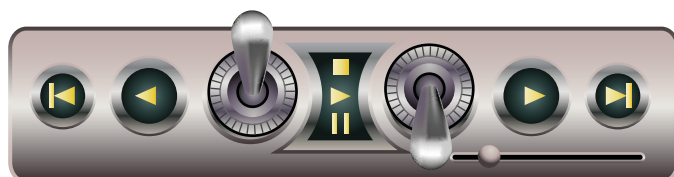
Accidents resulting in the damage or destruction of Army resources or personnel injury/death impair the combat readiness of the United States Army. The lessons learned from accidents provide the basis for prevention programs that help insure we don't repeat the mistakes of the past. These investigations can be extremely difficult, time consuming and stressful, but provide critical information for decision makers at all levels in Army Aviation.

As a Flight Surgeon or Aeromedical Physician Assistant, you will be called on to investigate the human factors in any Accident investigations your unit may take part in.

Objectives:

- a. **Apply Accident Investigation Principals of the Army Aviation Safety Program to the Army Aviation Medicine Program.**
- b. **Cite the regulatory guidance for The Army Aviation Safety Program, accident prevention, and accident investigation.**
- c. **Define a pre-accident plan, as well as the role of the FS/APA in the plan.**
- d. **Know the flight surgeon's role in accident investigation:**
- e. **Define accident investigation terminology and classifications.**
- f. **Define the CREEP principle and how to use it to assess injuries in an accident investigation.**
- g. **Know how to collect relevant Aviation Life Support Equipment (ALSE) and submit to USAARL's ALSE Retrieval Program (ALSERP).**





What role does human error play in accidents?

- Human error is a definite cause in more than 80% of all Army accidents.
- Human errors can usually be attributed to one or more of the following inadequacies: standards failure, training failure, leader failure, or individual failure.
- As a member of the accident investigation board, the flight surgeon is responsible for investigating the human factors aspect of the accident.



What is the focus of an accident investigation?
The focus of an accident investigation is to identify the system elements that permitted or caused the accident to occur.

The “3W approach” to accident investigation

The procedure used to identify inadequate systems elements and describe the human factors, material failures, environmental factors involved in accidents is called the “3W approach.”

This approach requires investigators to answer three questions:

1. What happened?

- Identify how the accident occurred.
- Identify key factors that contributed to the accident occurrence.

2. What caused it?

- Identify the errors/failures that caused or permitted the accident to occur.

3. What to do about it?

- Identify remedial measures that will correct the system inadequacy.

Regulations

What is the regulatory guide for The Army Aviation Safety Program, accident prevention, and accident investigation?

The regulations and Army publications that address these programs are:

Department of the Army Regulations:

- AR 385-10: Army Safety Program
- AR 385-95: Army Aviation Accident Prevention
- AR 385-40: Accident Reporting and Records
- AR 40-21: Medical Aspects of Army Aircraft Accident Investigation

DA Pamphlet:

- DA Pam 385-40: Aircraft Accident Investigation and Reporting

AR 40-3:

- AR 40-3, Chapter 3 - Aviation Medicine

Avoiding Accidents

What helps aviation units avoid accidents?

The U.S. Army Combat Readiness Center surveyed three battalion-sized aviation units that historically had excellent safety records to determine the characteristics that led to their exceptional safety records.

Optimum use of flight surgeons:

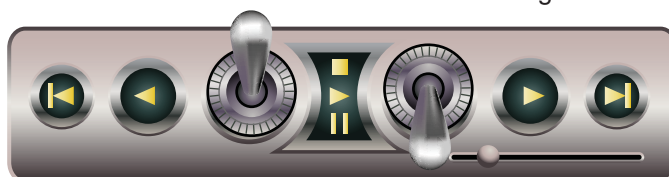
- Flight surgeons were used primarily in the aviation medicine specialty.
- Other medical duties of the flight surgeon were minimized.

Flight surgeons supported individual aviators:

- Flight surgeons knew most aviators well.
- Flight surgeons gave emphasis to individual aviator medical needs.

Flight surgeons were involved in the unit safety program:

- Flight surgeons were frequently involved in the unit safety briefings.
- Flight surgeons enhanced aviator knowledge of aeromedical aspects of flying.



Flight surgeons support of aviation units:

- Flight surgeons were extensively involved in unit aeromedical needs.
- Flight surgeons provided timely advice to commanders regarding aviation medicine matters.

Flight surgeon credibility:

- Flight surgeons were highly respected by the aviators surveyed.
- Flight surgeons were highly respected by the commanders surveyed.

What the unit flight surgeon does in response to one of his unit's helicopters going down depends on the unit's Pre-Accident Plan (also known as AC Mishap SOP).

4. Take part in and observe flight operations to monitor the interactions of crewmembers, aircraft and environment.
5. Monitor the physical and mental well being of aviation personnel, including drug or alcohol abuse and self-medication problems.
6. Monitor the survival and physiological training of aviation crewmembers.
7. Monitor the fitting, use, and serviceability of Aviation life support equipment (ALSE).
8. Take part in Aviation safety meetings to educate Aviation crewmembers on the aeromedical aspects of flight.
9. Insure that medical portion of the pre-accident plan is current and adequate.

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Items 1-9 (and the FEB part of 10) can be considered the Pre-Accident roles and responsibilities and are designed to prevent an accident. However, there will always be accidents despite our best efforts to avoid them.

Pre-Accident Plan**What is a flight surgeon's role in forming a pre-accident plan?**

- The flight surgeon's role in accident investigation begins well before the accident.
- AR 385-95 established the Army Aviation Accident Prevention function as an integral part of the Army Safety Program (AR 385-10).
- As part of this program, the flight surgeon assists and advises the command in all Aviation medicine matters.

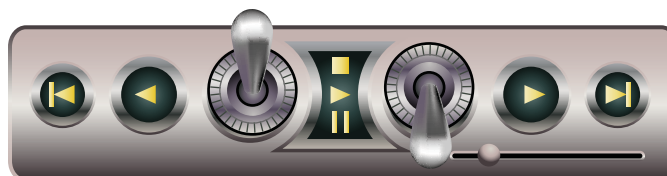
1. Serve as a member of the flight evaluation boards (FEB) and aircraft accident investigation boards.
2. Medically clear crewmembers for further flight duty after aircraft/incidents/accidents.
3. Make recommendations to improve the human factors aspects of aviation compatibility, crash worthiness, and survival features of aircraft.

The flight surgeon is required to perform the following duties:

1. Maintain liaison within the command to implement the Aviation medicine program.
2. Maintain aviation medical records on flight personnel.
3. Assist in and advise on hearing and eyesight conservation programs.

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The last three items can be considered Post-Accident roles. What is not implicit from the above roles are those responsibilities, duties, and tasks that must be performed immediately after notification of an AC mishap and during the ensuing accident data collection.



Why do pre-accident Planning?

- Aircraft accidents and emergencies occur suddenly or with a minimum of advance warning.
- They may result in fire and serious injury or death to occupants of the aircraft.
- It is extremely important that all members reacting to an aircraft accident, especially fire fighting and rescue personnel be trained to act as quickly and efficiently as possible.
- A pre-accident plan is required for all organizations operating Army aircraft
- Regulations do not discriminate between garrison and field pre-accident planning requirements

Parts of a Pre-accident Plan (AR 420-90):

- Establishes basic policies, procedures, and standards for aircraft rescue and fire-fighting services (ARFF)

- A pre-accident plan and training program is required for all Army airfields including temporary (field) airfields
- At non-Army airfields used by the Army either the airfield operator or if necessary the Army will provide aircraft fire-fighting and rescue services (Based on A/C movements)
- Installation fire chiefs may request the use of aviation unit personnel, equipment and aircraft for fire protection missions (para 1-14a)
- The MTF commander is responsible for the assignment of properly equipped and manned ambulances
- At least one ambulance, or substitute vehicle, with crew, will be on call during scheduled flying hours or at other times designated by the installation commander
- At non-Army airfields the ambulance service will be provided by the host installation commander (para 5-3)

Difference between a Pre-accident Plan and a Crash Plan:

All pre-planned procedures or advance preparation that will reduce the confusion that normally exists during emergency situations can be considered "pre-accident" planning.

The pre-accident plan should contain detailed instructions on everything from egress training and crash rescue drills, to individual duties and responsibilities.

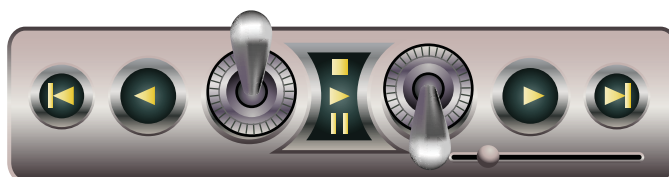
The Crash Plan is a checklist that lists all agencies, methods of contact, phone numbers and brief description of the steps to take when a mishap occurs.

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ARFF: Aircraft Rescue and Fire-fighting The consolidated efforts of the fire and medical emergency services which will respond in the event of an emergency.

- Ambulance personnel will be trained in emergency medical treatment and procedures for evacuation of injured personnel (para 3-4b)
- Ensure your pre-accident plan takes hazardous material incidents (spills, leaks, etc.) & BBP into consideration. Environmental regulations require organizations to have "contingency plans," contact your local environmental office for specific requirements.

Crash Alarm System

- An element of a pre-accident plan
- "Generally" in checklist form
- Listing both primary (Group I) and secondary (Group II) agencies, method for notification



(phone numbers) and “IMMEDIATE ACTION” steps to take when notified

- Primary – Emergency Rescue Response
- Secondary – Internal Unit Actions

Participants

Who plays a role in Pre-accident planning?

Operations officer (1-6c):

- Prepares and maintains the unit pre-accident plan, will use expertise of ASO and others
- Rehearses and reviews the pre-accident plan at least quarterly

Safety officer (1-6d):

- Rehearses and reviews the pre-accident plan with the operations officer at least quarterly
- Ensures all applicable agencies test, or are included in consolidated training, for their portion of the pre-accident plan
- Assists the accident investigation board
- Prepares the accident report and makes a preliminary classification of the mishap (6 P's apply here!)
- Reviews all reports before submission (AR 385-40)

Flight surgeon (1-6g):

- Ensures the medical portion of the pre-accident plan is adequate
- Supervises and plans the training of crash rescue medical personnel
- Assists the accident investigation board as required

What is the flight surgeon's role in accident investigation?

1. When the call is received, find out:

- Status and number of occupants
- Type of aircraft.
- Location of accident.

- Type of mission, armaments, and weapons onboard.

2. At the crash site:

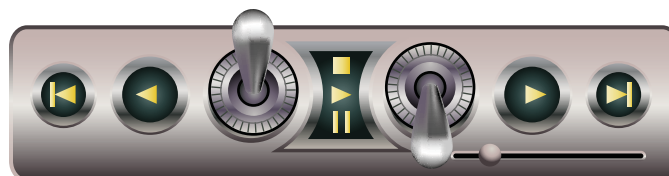
- Make sure area is safe from armaments, toxic materials, armed ejection seats etc.
- The first priority is the triage, treatment and evacuation of casualties.
- The wreckage should be disturbed as little as possible in the process of removing personnel.
- Keep your hands in your pockets and just observe for the first walk-through.
- Confirm and declare dead victims.

Bodies of deceased personnel should be covered and left where they are for the period required to take photographs or make sketches documenting their posture and relative position. Confirm jurisdiction prior to moving bodies.

- Account for all body parts and personal equipment and mark their exact location.
- Determine and document position of bodies when initially found by crash/rescue personnel.
- Determine and document whether life support equipment was removed or altered (i.e., flight suits cut, helmets removed, restraint harnesses cut).
- Document time of day, weather conditions, and terrain.
- Body fluids from fatalities should not be collected on-the-scene. The autopsy is the proper time to collect toxicology specimens.
- Photograph accident site, wreckage, fatalities, restraint systems, ALSE equipment (see Photography section).
- Supervise recovery of bodies and accompany them to medical facility.
- Do not remove personal equipment from the body before, radiographs are taken and the autopsy.

3. At the medical facility:

- Evaluate survivors to include making sure toxicology specimens are collected.
- Secure all flight equipment, medical and



dental records for survivors and fatalities.

- Assist radiologist in obtaining full body radiographs with equipment and personal gear on.
- Confirm notification of AFIP by U.S. Army Combat Readiness Center.
- Complete DA Form 3894 – Hospital Report of Death. “Time” is time of death declared by you. Cause of death is your best estimate; this may be changed on the death certificate after autopsy.

4. Later that day:

- Meet with arriving Combat Readiness Center personnel.
- Meet with arriving pathologist from AFIP. Take him to accident site if possible, prior to conducting autopsy.
- Attend/assist with autopsy. Make careful notes of any damage to flight helmets, boots, flight suits, gloves, and flight vest. Obtain a copy of autopsy report from pathologist.
- Collect all damaged ALSE equipment (helmet, vest etc.) and contact USAARL for shipment to them for further evaluation.
- Sign Death Certificate after autopsy, and insure body is released to next-of-kin.

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**Remember! The Combat Readiness
 Center Surgeon is always
 a good consultant if help is needed.**

Toxicology Specimen Collection

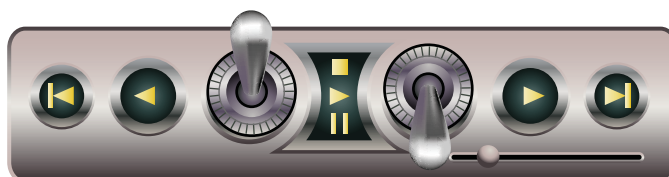
Survivor – Toxicology Collection

- Toxicology samples will be collected for all Class A, B, and C accidents.
- Specimens should be collected at the local medical facility immediately following the accident.
- All toxicological examinations will be performed at the Armed Forces Institute of Pathology (AFIP).
- Do not perform test locally.
- Guidance is at:
<http://www.afip.org/Departments/oafme/tox/tox.html>

Survivor toxicology collection procedures:

- Prepare skin with betadine or soap and water.
- Do not use alcohol.
- The above specimen should be collected by chain-of-custody conditions IAW AR 600-85, from the moment they leave the crewmembers body to the time of their delivery at AFIP, they should be secured.
- DD/AFIP Form 1323: Toxicological Exam – Request and Report will be completed and sent with specimens.
- A copy of all toxicology results is sent directly to the Combat Readiness Center to be placed in the accident report. A second copy is usually sent to the facility where the specimens were collected.
- AFIP routinely screens for the agents listed below:

Acetaminophen	Amphetamines	Antihistamines	Antidepressants	Barbiturates
Benzodiazepines	Carbon Monoxide	Cannabinoids	Cocaine	Diuretics
Ethanol	Morphine	Narcotic Analgesics	Neuroleptics	Nicotine
NSAIDs	Phencyclidine	Phenothiazines	Salicylates	Sympathomimetic Amine



Autopsy

Autopsy Procedures can be found at:

<http://www.afip.org/Departments/oafme/index.html>

- Army Regulation 40-21 requires an autopsy be performed on all fatally injured Army air crewmembers.
- Whenever possible, AFIP will conduct the autopsy.
- The flight surgeon assigned to the accident board should assist the pathologist and be prepared to obtain the required aeromedical information.
- The Army has exclusive jurisdiction only when the accident occurs on property under exclusive federal control. In this case, the Armed Forces Medical Examiner (AFME) has the authority to order the autopsy.
- However, most accidents involve concurrent jurisdiction.
- For this reason, the flight surgeon must establish a good working relationship (prior to the accident) with the local coroner or medical examiner.

What is the procedure for concurrent or civilian jurisdictions?

If the jurisdiction is concurrent or exclusively civilian, then the coroner or medical examiner may:

- Retain jurisdiction and perform the autopsy;
- Retain jurisdiction and request that a representative of the Armed Forces Medical Examiner (AFME) perform the autopsy under his jurisdiction;
- Waive jurisdiction to the Army, in which case the AFME will order the autopsy;
- Retain jurisdiction and not perform the autopsy. He will release the body to the next-of-kin, which may authorize the autopsy by a military pathologist.

What is the procedure for Army autopsies?

- When a fatal aircraft accident occurs, the U.S. Army Combat Readiness Center immediately requests assistance from AFIP.
- Whenever possible, AFIP will conduct autopsies on these fatalities, however, they will not launch a team until jurisdiction is determined.
- If possible, prior to the autopsy AFIP will visit the accident site in an effort to correlate injury patterns, aircraft surfaces, and damage.
- Prior to departure they will provide the flight surgeon with a written autopsy protocol that includes a statement of injuries and evidence for identification.
- A finalized report is sent directly to the U.S. Army Combat Readiness Center to be included in the accident report.

Autopsy Objectives:

A Identify the dead.

Identify the cause of death.

Identify the manner of death.

Identify the nature and sequence of traumatic events.

Identify specific interactions between the victim, the aircraft structure, or components resulting in the sustained injuries.

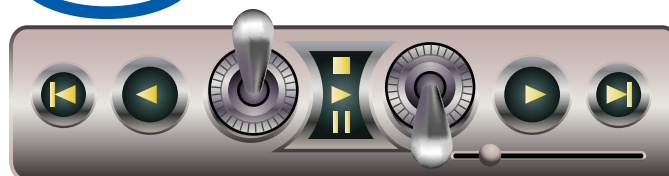
Estimate crash survivability.

Identify post impact injuries and attributable causes.

Determine who was in control.

Identify physiological or medical cause factors.

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Based on autopsy results, the flight surgeon must determine if any modifications of the aircraft or its equipment would have improved chances of survival for those killed, or reduced the severity of injury to the survivors.



Post-Autopsy

Post-Autopsy Actions

What is done with body parts after an accident?

- If body parts are found late in the investigation, the flight surgeon should take possession of them and call AFIP to determine if they are of use in the investigation.
- If they are, AFIP will direct what to do.
- If they are not, it is the flight surgeons responsibility to insure that they are disposed of properly at the nearest military medical facility pathology department.
- Following completion of the autopsy, the prompt release of remains to the next-of-kin is extremely important.

Intent to fly. Exists when an aircraft engine is started for the purpose of commencing authorized flight (scheduled flight by a rated crew).

- Intent to fly continues until the aircraft comes to rest (brakes set or wheel chocks in place with engines, propellers or rotors stopped).
- An aircraft's engines are considered started or running the instant an attempt is made to set any one engine in motion, either by power from within or outside the aircraft.
- Intent to hover a helicopter under its own power from its parked position will be considered in flight.
- For amphibious aircraft landing on water, intent for flight ceases when the aircraft has made a water landing, engines have been stopped, and the aircraft has either been moored or taken in tow.
- Helicopters designed to be capable of landing on water and remaining afloat are not considered amphibious aircraft.

Positive Identification Requirements:

Positive identification of victims requires comparison of antemortem and postmortem fingerprints, footprints, dental records; or DNA typing.

Presumptive identification includes visual (marks, tattoos, etc.), personal effects, I.D. tags, physical characteristics, radiography and flight manifest.

Flight accidents. Those accidents where there is reportable damage to the aircraft itself. Explosives, chemical agent, or missile events that cause damage to an Army aircraft with intent to fly are categorized as flight accidents.

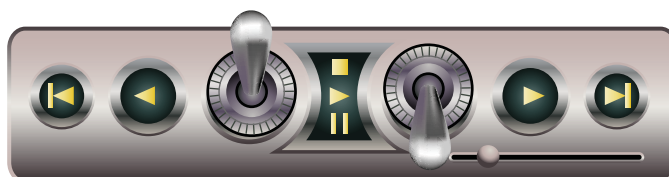
Flight-related accidents. Those accidents where there is reportable damage to the aircraft itself; for example, injury to ground crew or passengers or other property damage.

Accident Investigation Terminology

Army accident. An unplanned event that does damage to persons) or property exclusive of damage caused by action of an enemy or hostile force

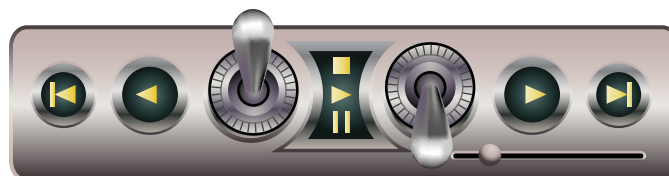
Army aircraft accident. An accident involving Army aircraft or Government aircraft operated by the Army when the intent to fly exists.

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A parachutist or rappeller outside an aircraft is not considered to be a passenger for aircraft accident reporting purposes unless injured as a result of flight crew.



Accident Classification (AR 385-40)

Class A	<ul style="list-style-type: none"> An Army accident in which the resulting total cost of reportable property damage is \$1,000,000 or more An Army aircraft or missile is destroyed, missing abandoned, or economically unrepairable An injury and/or occupational illness resulting in a fatality or permanent total disability 	<p>A single component/part failure:</p> <p>Resulted from fair wear and tear (FWT) (part cost not a factor).</p> <p>The FWT rule is excluded when the failed part causes/contributes to damage to another component, system, or equipment (for example) battery failure results in an engine hot-start).</p> <p>Should additional damage or injury be incurred during continued operation, landing, or emergency procedures after the above events, the accident classification will be reported based on the total damage cost or injury severity.</p> <p>Foreign Object Damage (FOD) incident</p> <p>Reportable incidents confined to turbine engine damage as a result of internal or external FOD.</p>
Class B	<ul style="list-style-type: none"> An Army accident in which the resulting total cost or reportable property damage is \$200,000 or more, but less than \$1,000,000 An injury and/or occupational illness results in permanent or partial disability When five or more personnel are inpatient hospitalized 	
Class C	<ul style="list-style-type: none"> An Army accident in which the resulting total cost of reportable property damage is \$20,000 or more, but less than \$200,000 A nonfatal injury that caused any loss of time from work beyond the day or shift on which it occurred < time (lost any at disability or day) work 1 (e.g., from of loss causes that illness nonfatal> 	
Class D	<ul style="list-style-type: none"> An Army accident in which the resulting total cost of reportable property damage is \$2,000 or more, but less than \$20,000 A nonfatal injury that does not meet the criteria of a class C accident (no lost time case). 	
Class E	<ul style="list-style-type: none"> An incident (material failure/ malfunction, human, or environmental cause) which interrupts/prevents a mission when intent to fly exists. Conditions are: <ul style="list-style-type: none"> Property damage must be less than \$2,000 No lost/restricted time case 	



CREEP Principle

CREEP is an acronym for crash survival factors:

C – Container

R – Restraints

E – Environment

E – Energy Absorption

P – Post-crash Factors

Crash Survivability

CREEP factors take into account:

- Tolerable deceleration forces
- Maintaining sufficient volume of occupiable space
- Non-lethal post crash environment
- Time to definitive medical care

Container:

- In order for a crash to be survivable the aircraft structure must maintain integrity and preserve an adequate volume of living space and prevent penetration by objects throughout the crash sequence.
- Modern helicopter design provides reasonably good protection when the helicopter remains upright.
- However, due to the lightness of the cockpit/cabin overhead structure, the helicopter generally provides little protection during rollover accidents.

Restraints:

- It is critical for impact survival that occupants be securely restrained.
- Failure of the restraint system results in a much higher probability of injury.

Environment:

- Even when properly restrained, injuries may result through contact with various surfaces/objects in the aircraft.
- Loose items may become missiles on impact causing injuries; and possibly hampering rapid egress.

Energy Absorption:

- To prevent injury during a crash, the airframe and seat must attenuate the crash forces transmitted to the occupants.
- This may be accomplished through the use of energy absorbing materials and designs located between the occupants and the point of impact.

Post Crash Factors

- Post crash fire, toxic fumes, poor communications, remote location, and inadequate training can adversely affect survival.
- A delay in rescue and time to definitive medical care can result in major injuries becoming fatal injuries.

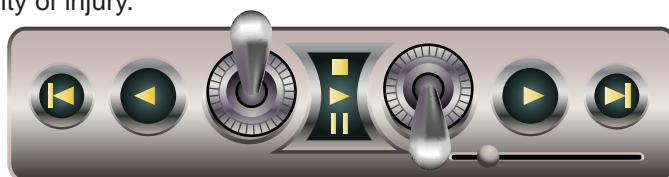
Impact Tolerance

Survivable Accident

- An accident in which the impact conditions are within human tolerances, and crew and passenger occupiable space remains reasonably uncompromised.
- Post crash factors must be such that successful egress is possible.

Human tolerance to abrupt acceleration depends mainly on:

- Magnitude of the accelerating force
- Duration of the accelerating force
- Rate of onset of the accelerating force
- Direction in which the acceleration force is applied to the body
- Manner in which the occupant's body is supported during the acceleration



Whole body impact tolerance limits (based on 250G/sec. onset rate; using restraint system):

-Gx (eyeballs out)	45 G over 0.1 sec 25 G over 0.2 sec
+Gx (eyeballs in)	45 G over 0.1 sec 83 G over 0.04 sec
-Gz (eyeballs up)	15 G over 0.1 sec
+Gz (eyeballs down)	25 G over 0.1 sec
Gy (eyeballs left or right)	11.5 to 20 G over 0.1 sec

Determine the rough Probability of Survival based on the above table:

- If human tolerance limits exceeded by a factor of 2 or more, survival is unlikely.
- If human tolerance limits exceeded by a factor of 1.5, survival is doubtful.
- If human tolerance limits exceeded by a factor of 1.25 or less, survival depends on specific CREEP factors.
- If limits are not exceeded, survival is expected.
- When the crash forces are not clearly in X, Y, or Z-axis, extrapolate.

Deceleration Injuries:

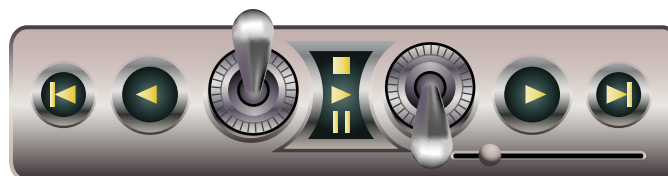
Typical impact G forces required to induce the specified injury:

Pulmonary Contusion	25 G
Nose fracture	30 G
Vertebral body compression	20-30 G
Fracture/dislocation of C1/C2	20-40 G
Mandible fracture	40 G
Maxilla fracture	50 G
Aorta tear	50 G
Aorta transection	80-100G
Pelvic fracture	100-200G
Vertebral body transection	200-300G
Total body transection	200-300G
Concussion	60 G over 0.02 sec
	100 G over 0.005 sec
	180 G over 0.002 sec

ALSE Evaluation

What is Aviation Life Support Equipment (ALSE) Evaluation?

- The flight surgeon, IAW AR 40-21 is required to correlate the factors causing the accident and injuries with system design, personal equipment and regulations.
- This includes evaluation of life support and personal protective equipment that is in any manner implicated in the cause or the prevention of injuries.
- Any suspect equipment should be sent to the U.S. Army Aeromedical Research Laboratory (USAARL) for further analysis.



- The U.S. Army Aeromedical Research Laboratory manages the aviation Life Support Retrieval Program (ALSERP).
- The purpose of this program is to evaluate and record the efficiency of Aviation Life Support Equipment (ALSE) in the aircraft accident environment.
- Personal injury data are correlated with the item of ALSE provided for protection, along with information on the accident kinematics and dynamics.
- These ALSE items are assessed for damage to determine if the design was adequate, if it was manufactured to design, and/or if it was properly worn by the crewmember. The data is further used to identify design deficiencies and to substantiate the need for system improvements.
- The ALSE that may be sent to USAARL includes: helmets, seats, restraint systems, inertia reels, survival vests and flight suits.

Where do we send all equipment requiring further evaluation?

**U.S. Army Aeromedical Research
Laboratory**

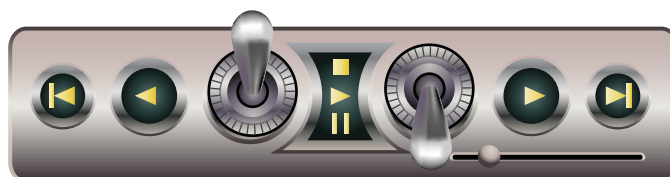
ATTN: UAD ALSERP Program

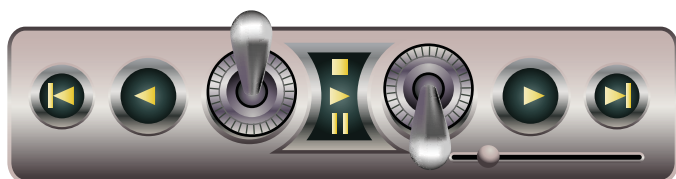
Building 6901

Fort Rucker, AL 36362-0577

**Notify USAARL prior to shipping: DSN 558-6804/6893
COMM (334) 255-6804/6893**

**or to answer any questions regarding ALSE damage,
POC Mr. Licina.**





US Army School of Aviation Medicine
301 Dustoff
Fort Rucker , AL 36362

334 • 255 • 7460
<http://usasam.amedd.army.mil>

